FOUNDRY TRADE JOURNAL
Established 1902
WITH WHICH IS INCORPORATED THE IRON AND STEEL TRADES JOURNAL

Vol. 72 Thursday, February 24, 1944 No. 1436

The Structure of Industrial Wages

Industry has for several decades been over-impressed by the obvious fairness of payment by results. The trade unions instinctively rather than logically opposed the new idea. With the passage of time, however, they have acquiesced and have seen with satisfaction the increase in the value of the pay envelopes of the piece-workers, and a corresponding strength of their own financial resources. Coupled with this there is a general movement to give the unskilled workers in industry a wage commensurate with that paid to the semi-skilled piece-workers. The net result, however, has been to create such anomalies in the industrial wages structure as to amount to chaos. At present it is prominent in the mining industry, where a laudable attempt to ameliorate the conditions of the lowest paid grades of workers has so narrowed the margin of remuneration between this class and the more highly skilled miners that discontent is manifest. We well remember, during the last war, the foreman in charge of a steelfoundry on the North-East Coast complaining to us that he was the worst paid man in the shop. His two chargehands received less money than the moulders, who in turn were worse paid than the labourers. Similar conditions are again showing themselves and one general manager not long ago received a round robin from his foremen facetiously asking to be found jobs as machine minders! Such cases could be enlarged upon from one's personal experiences. If wage levels are to be placed on sensible bases, the payment by results system will have to be readjusted and replaced by one which will limit the earnings of semi-skilled to the region lying between the unskilled and the skilled. Equity demands that the payment of staff should be based on the following: If the day rate of a labourer be x, then that of the semi-skilled should range between x and 2x, that of the skilled man between 2x and 3x, the chargehands 3.5x, foremen and under-managers 4x to 5x, and departmental managers 10x to 20x, depending on the size of the shop. Under such a system, many parents would at least know where they stood, and be assured that the learning of a trade or profession was worth the sacrifice it involved. Again, if a skilled man preferred the job of a tram conductor, with its guarantee of regular employment, he would have to make a financial sacrifice and not, as has often been the case, receive an increase in remuneration. If the basis, or a modification of what we have indicated, be accepted as logical, then with it should go corresponding rates for unemployment allowances. The above may sound Utopian, but be that as it may, it would be preferable to the present chaotic conditions, which have negatived, at least temporarily, financial incentives to take up a trade. If at any time there is a Royal Commission established to investigate the payment of wages, we hope that due attention will be paid to "skill," and stress the lack of equity in a system which accords the same rate of wages to the most skillful craftsman as to the least. Surely it would be preferable to have a system based on a standard rate with a fixed floating percentage to be paid over to the more highly skilled at the discretion of a production committee. By this means all union shops would be paying the standard rate, but not all skilled men would be equally remunerated. It might be said that there is no need for such a system to be tied up in a trade union agreement, but personal experience has taught us that rewarding one or two men for good work by an increase in rate was not appreciated and that the rule "equal pay for equal work" was being broken. To reorganise the whole of the structure of wages is obviously a Herculean task fraught with great difficulties, but surely no greater than the one the country has undertaken to beat Germany.

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B.C.I.R.A. ELECTS NEW MEMBERS

The following firms have joined the British Cast Iron Research Association. The name of the accredited representative is shown between brackets:—

Alcock Ashdown & Company, Limited, Bombay (Mr. D. D. Carcary); the Alliance Foundry Company, Limited, Luton (Mr. K. T. J. Bone); Allied Ironfounders (Ireland), Limited, Waterford (Mr. A. H. Masser); W. S. Barron & Son, Limited, Gloucester (Mr. G. S. Barron); Barry, Henry & Cook, Limited, Aberdeen (Mr. V. Cook); Borough Engineering Works, Limited, Luton (Mr. W. D. Joslin); Central Foundry Company, Limited, Oldbury (Mr. J. Campbell); Davy, Paxman & Company, Limited, Colchester (Mr. E. P. Paxman); Enfield Foundry Company, Limited, Waltham Cross (Mr. D. G. Bisset); Fine Castings, Limited, Bristol (Mr. I. Rees); Gloucester Foundry, Limited, Gloucester (Mr. T. Potter); Government of India Central Standards Office for Railways, New Delhi (Mr. E. Ingoldby); Chas. Haley & Company, Limited, Bradford (Mr. N. W. Green); Henry William Hendra, trading as H. Hendra & Son, Croydon (Mr. H. W. Hendra); Hopyard Foundries, Limited, Caseley (Mr. A. Allen); John King & Company (Leeds), Limited, Leeds (Mr. J. E. S. King); Knete Castings, Limited, Brentwood (Mr. A. C. Howard); S. Lacey & Sons Pty., Limited, Sale, Australia (Miss J. J. Lacey); The Laycock Engineering Company, Limited, Sheffield (Mr W. G. Pallett); W. N. Nicholson & Sons, Limited, Newark (Mr. A. C. Nicholson); Mr. Harry Nuttall, Rochdale; G. D. Peters & Company, Limited, Slough (Mr. J. E. Blackshaw); Renshaw Foundry, Limited, Staines (Mr. G. W. Bush); Thomas Richards & Sons, Limited, Bristol (Mr. D. A. Richards); Stothert & Pitt, Limited, Bath (Mr. A. E. Perry); Andrew Strang & Company, Limited, Hurlford (Mr. J. A. Charlton); Swinney Brothers, Limited, Morpeth (Mr. N. Swinney); Sykes & Harrison, Limited, Manchester (Mr. S. G. Harrison); Tonge & Taggart, Limited, Dublin (Mr. I. C. Tonge); Stuart Turner, Limited, Henley-on-Thames (Mr. H. Sanderson); John Urmson, Limited, Ashton-under-Lyne (Mr. G. Osgood); Wyndham Hewitt, Limited, Staines (Mr. W. A. Green). *As User member:* High Duty Alloys, Limited, Slough (Mr. F. J. S. Lawrence).

Foundry Queries

Rust Prevention.—A reader requires a fluid into which shot-blasted castings can be immersed to prevent rusting before machining.

Shovel Barrows.—Information is required as to where a type carrying the trade name of Lanwade can be obtained.

CATALOGUE RECEIVED

Thermoplastic Cables. A further contribution to this interesting development is made by the issue of pamphlet No. NSC11, by British Insulated Cables, Limited, Prescot, Lancashire.

CORRESPONDENCE

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

BUILDERS' CASTINGS

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In your Leader of February 17 you say: "We have failed to satisfy ourselves that the foundry industry is tackling this problem of post-war housing correctly."

The failure is all yours. The Builders' and Cabinet Section of this Association has been represented at meetings held under the auspices of the British Standards' Institution, working in collaboration with the Ministry of Works, which were also attended by representatives of the iron foundry industry and others concerned.

As a result, considerable progress has been made towards the specification of standard articles of iron foundry and brassfoundry hardware for the post-war housing schemes.

It should be noted that this Association is concerned with the manufacture of goods known as brassfoundry, whilst I believe your sphere of activities is more concerned with work in a foundry shop, and perhaps, therefore, your closer connection with the heavy engineering side of our industry has made you oblivious to the activities of this lighter, but no less important side of the industry.

Yours, etc.,
EDGAR N. HILEY
(Secretary of the National Brassfoundry Association).

106, Edmund Street, Birmingham, 3.
February 18, 1944.

[It is precisely because we are well aware of Committee Representation that we wrote the Leader on Builders' Castings, and we withdraw nothing.—EDITOR.]

NOTES FROM THE BRANCHES

Lancashire Branch, Burnley Section.—The monthly meeting was held at the Municipal College on February 15, when Mr. A. R. Palmer, of the Northern Diecasting Company, Limited, spoke on "Gravity Diecasting." A large and representative audience followed a clear and detailed explanation with great interest. Several samples were exhibited and drawings shown by lantern.

THE NICKEL BULLETIN

The January issue contains abstracts dealing with the chemical analysis of metals, reclamation of worn parts, tin-nickel alloy coatings in food preservation, weld bead hardness tests, stress-corrosion cracking of stainless steel in chloride solutions, and "design strengthening" of aircraft materials.

Copies may be obtained, free of charge, from The Mond Nickel Company, Limited, Grosvenor House, Park Lane, London, W.1.

TEST-BARS FOR BRONZE CASTINGS*

A plea is made for nationally standardised test-bars

By W. A. BAKER, B.Sc.

The following Paper is mainly an account of some experiences with various forms of bronze test-bars, but its object is to raise the general question of standardisation of test-bars for non-ferrous castings and to emphasize the need for such standardisation. The light alloy industry has long standardised on the top-poured D.T.D. test-bar, and there seems to have been little demand for modification of this standard. A wide variety of test-bars is used in the copper-base and other non-ferrous alloy castings industry, with the result that test figures obtained in various foundries and laboratories are not strictly comparable and, in fact, they rarely agree as closely as could be desired. This is particularly true of the bronze and brass casting industry where the variations in size, shape, gating and feeding of test-bars is really remarkable. Results which have become available using various forms of test-bar in the British Non-Ferrous Metals Research Association's work on bronze castings clearly show that standardisation is long overdue, and this obviously holds not only for the bronzes and brasses, but also for the other non-ferrous casting alloys.

* A Paper presented to the London Branch of the Institute of British Foundrymen, Mr. H. W. Lockwood presiding. The author is on the staff of the British Non-Ferrous Metals Research Association.

Requirements from Test-bars

The Research Association has been investigating casting of bronzes with the object of improving industrial castings, and much of the work has been done on sand castings. It is well known that the bronzes have very good casting characteristics, but porosity is frequently encountered, causing weakness and leakage under pressure. This porosity is known to be due to two causes, namely, shrinkage and dissolved gases and the first essential requirement in a study of the causes and control of this porosity was a test-bar which would meet the following requirements:

(1) First, the test-bar should be so well fed as to reduce shrinkage porosity to a minimum, so that gas-free material would give bars having the best possible mechanical properties. These could then be used as a standard of reference for judging the effects of shrinkage and gas in castings whose shape makes perfect feeding extremely difficult, if not impossible. A sound test-bar is also essential to allow the detection of effects of impurities other than dissolved gas; the effects of such impurities might be obscured by the effects of the porosity, if any was present.

(2) Secondly, the test-bar should be sensitive to the presence of gas in the metal, so that its properties

TABLE I.—*Densities of the Ends of Broken Test Pieces.*

Untreated.				Treated.			
Cast No.	Bar density before machining.	Density of end X.	Density of end Y.	Cast No.	Bar density before machining.	Density of end X.	Density of end Y.
D.N.E.				D.N.E.			
286 1U (A) ..	8.659	8.479	8.382	286 1T (B) ..	8.717	8.685	8.406
286 2U (A) ..	8.653	8.443	8.429	—	—	—	—
287 1U (C) ..	8.661	8.443	8.411	—	—	—	—
287 2U	8.632	8.394	8.393	—	—	—	—
288 1U	8.588	8.335	8.233	288 1T (C) ..	8.736	8.617	8.425
288 2U (A) ..	8.600	8.437	8.370	290 2 (B) ..	8.785	8.793	8.641
289 1U (C) ..	8.627	8.475	8.442	291 1T (C) ..	8.711	8.694	8.429
289 2U (B) ..	8.635	8.306	8.274	292 2 (B) ..	8.759	8.788	8.635
				294 1 (B) ..	8.685	8.649	8.406
Average ..	8.632	8.414	8.367	294 2 (B) ..	8.676	8.547	8.390
				295 1 (B) ..	8.688	8.596	8.483
				295 2 (B) ..	8.691	8.668	8.500
				296 2 (B) ..	8.717	8.697	8.459
				297 2 (C) ..	8.712	8.633	8.444
				298 1 (B) ..	8.728	8.720	8.462
				Average ..	8.717	8.674	8.473

(A) Broke at gauge mark. (B) Broke in grips. (C) Broke outside gauge length.
The ends of the specimens in the above table are thus :—
End X : Complete end. End Y. : End where fracture has occurred—either in screw thread or outside gauge length

Test-Bars for Bronze Castings

would indicate whether gas was likely to be responsible for effects observed in other forms of castings.

(3) The test-bar should be as simple as possible in order to minimise moulding variables and, incidentally, to save time and trouble in making it.

(4) The bar should use the minimum weight of metal.

These requirements are obviously the same as those for acceptance test-bars in industry, although the last two named conditions assume less importance in research than in foundry control. In foundry control the man-power and weight of metal required for casting and machining test-bars may become very important indeed, especially so for the bronzes where melting units are usually fairly small. There is an obvious advantage in standardising on a test-bar for both research and foundry control wherever this is possible.

At the beginning of the investigation on bronze castings there was no generally accepted standard form of test-bar or even one which was more generally used than any other. However, most of the industrially used test-bars were horizontally cast bars gated and fed in various ways, and many attempts were made to adhere to this general form. The first experiments were with horizontal cast to shape bars, only 0.57-in. dia. on the parallel portion. This bar was soon abandoned because it failed to meet the second specified condition, that is, when gas was present, its effect was minimised by the comparatively rapid cooling of the thin section, and the test-bar properties did not discriminate sufficiently well between gassy and degassed material.

TABLE II.—90/10 *Tin Bronze. Pouring Temperature,* 1,150 *deg. C.*

Mould.	Condition of Metal	No. of bars.	U.T.S. tons per sq.in.	E per cent. on $4\sqrt{A}$.	Density
Type D. Star Gate Bar poured green Cross-runners 0.75 in. dia.	Untreated	8	11.0	8	8.62
	Treated	6	15.0	17	8.73
Type D. Star Gate Bar poured green. Cross-runners, 0.375 in. dia.	Treated	6	16.8	20	8.76
Type D. Star Gate Bar, poured dry Cross-runners, 0.375 in. dia. ..	Treated	4	18.6	33	8.69

The Institute Bar

Experiments were then made with the test-bar recommended about that time by the Non-Ferrous Sub-Committee of this Institute, namely, a horizontal shaped bar, ¼-in. dia. on the parallel portion. Fig. 1 shows two such bars with a common gate arranged for simultaneous pouring, with the runners made large so that the mould would be filled as quickly as possible. It is obvious that, when pouring is complete, the metal in the ingate end of the bar and in the attached riser is hotter than that in the far end and its attached riser, the metal reaching the far end giving up some of its heat in its passage through the mould. This temperature difference would tend to delay solidification near the ingate end and might promote more shrinkage porosity at that end than at the other, particularly at the change of section in the bar. For this reason pouring was as fast as possible to minimise this temperature difference. A large number of bars were made from gassy and slightly gassy 90/10 and 88/10/2 bronzes, and the tensile test results were very erratic indeed and generally low, *e.g.*, of the order of 10 to 15 tons per sq. in. for material with a fairly high density, *e.g.*, 8.74 (the

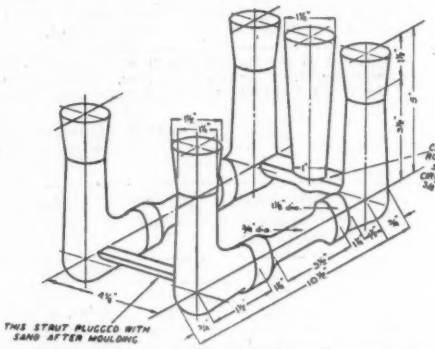


FIG. 1.—I.B.F. TEST PIECES ARRANGED AS DOUBLE BAR PATTERN.

TABLE III.—*Tensile Properties of Bronze D.T.D. Test Bars.*

Alloy.	Pouring temperature.	Degassed material. Density gm. c.c.	U.T.S. tons per sq.in.	E per cent., $4\sqrt{A}$.
90/10 deoxidised with 0.07 per cent. P	Deg. C. 1,150	8.84	20.2	37.5
89.8/10/0.2 Phosphor-bronze ..	1,050	8.80	23.0	43
87.5/9.5/3 gunmetal	1,150	8.79	19.1	20

maximum density of lead-free bronzes is of the order of 8.90 to 8.93 gm. per cc.).

A large proportion of the specimens failed outside the gauge lengths at a position corresponding with the change of section. Density measurements on the unworked ends of the broken specimens showed that the two ends were much less sound than the bar as a whole, showing that the changes of section caused concentrations of porosity to appear near them. Also, the end where fracture occurred was always less dense than the other, the difference being most marked when the density of the whole bar was high, that is, when the metal had a low gas content. These results are shown in Table I. The untreated material received no degassing treatment; the treated material was partially degassed. The difference between the two ends is clearly due to unequal temperatures at the two ends of the bar, due to loss of heat during pouring by the metal flowing to the riser end. Some further tests were done, eliminating the reduced section at the middle of the bar, but these bars also had very poor and erratic strengths.

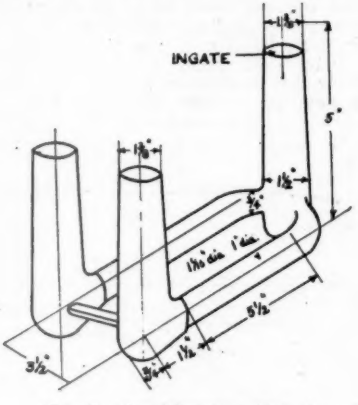


FIG. 2.—1ST MODIFIED BAR.

TABLE IV.—*Comparison of Tensile Properties of D.T.D. and Keel Bars in Manganese Bronze and Aluminium Bronze.*

Nominal composition of alloy. Per cent.	Pouring temperature, deg. C.	D.T.D. Bar. U.T.S., tons persq.in.	D.T.D. Bar. E per cent. $4\sqrt{A}$.	Keel Bar.* U.T.S., tons persq.in.	Keel Bar.* E per cent. $4\sqrt{A}$.
55 Cu, 41 Zn, 2.0 Ni ..	1,000	25.7	8	33.0	17
1.0 Al, 0.8 Fe, 0.2 Mn ..	950	29.1	12	33.0	17
79.5 Cu, 10 Al, 5 Fe ..	1,200	41.4	7½	46.3	18
5 Ni, 0.5 Mn ..	1,150	35.3	4	46.7	16

* The keel bar was a simple wedge 6in. long and 4 in. deep, 1 in. diameter half-round at the bottom, increasing in thickness up to 1.5 in. The results quoted are the means of two bars in each case.

Modified Test-bars

A number of modified test-bar shapes were then cast from two large melts, one substantially degassed and the other slightly gassy. The test-bars were 6 in. long and 1 in. dia., and they were cut into seven equal short lengths. The densities of these pieces were measured and plotted against their positions in the test-bar, the resulting curves then showing the distribution of porosity along the length of the test-bars.

In the first modification two horizontal parallel bars were run from a common gate, each having a separate riser. The bar is shown in Fig. 2. The object in this design was to provide two large masses of metal in close proximity at the far end of the mould, which would tend to eliminate the inequality in temperature at the two ends. Similarly, since the metal in the common ingate was required to provide heat flow, and therefore feeding liquid to both bars, this would tend to increase the rate of cooling of the gate and also balance the feeding of the two ends of the bars. Densities of short lengths cut from the bar are shown in Fig. 3 (lower curves). On the whole, the porosity is distributed fairly uniformly along the lengths of the bars.

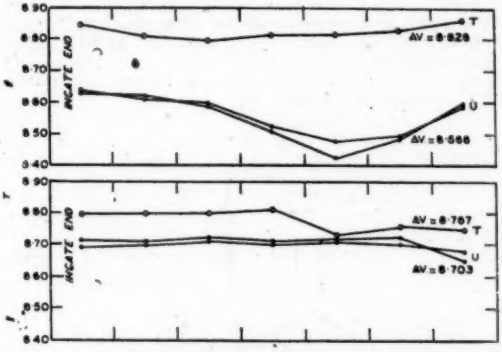


FIG. 3.—VARIATIONS IN DENSITY ALONG DIFFERENT TYPES OF SAND CAST TEST BAR.

In the second modification two horizontal parallel bars were gated and fed from one end only, with a pencil vent at the far end of the bars. The casting is shown in Fig. 4. Density explorations as before gave the results in Fig. 3 (upper curves). Again the distribution of porosity was fairly uniform in high-density bars, although low-density bars showed marked concentrations of porosity.

The third test-bar tried was the top poured D.T.D. bar commonly used for light alloys (see Fig. 5). The

Test-Bars for Bronze Castings

density of the specimens cut from this bar increased slightly towards the gate end and the overall density was appreciably higher than was obtained from the other bars tested (see Fig. 6, lower curves). The upper curves in Fig. 6 show the porosity distribution in the double I.B.F. mould with the reduced section eliminated. The distribution is fairly uniform, although, as mentioned earlier, such test-bars were found to have erratic and low strengths.

The test-bar with a single downgate, two horizontal bars and two risers was selected for further work partly because it gave a fairly uniform distribution of porosity and partly because it was similar in form to the bars used in industry. The test-bar was used for an investigation on degassing plain tin bronzes, and generally gave consistent and reproducible results. For example, degassed material from small melts gave the following properties:—Density, 8.71 to 8.80 (mean 8.75); tensile strength, 18.0 to 20.0 tons per sq. in. (mean 19.3); and elongation, 23 to 34 per cent. (mean 28)—average of 14 bars.

However, the degassing treatment developed in these tests was applied to 100-lb. melts and test-bars with slightly higher densities (8.78 average) were obtained which, nevertheless, had slightly lower strength (18.3 tons per sq. in. and 25 per cent. elongation). Micro-examination showed that local concentrations of shrinkage porosity were again tending to appear near one end of the bars, and an attempt was made to eliminate it by increasing the area of the ingate using the bar shown in Fig. 7. This did not eliminate the trouble, high-density bars (8.76) having strengths of only 15.8 tons per sq. in. and 20 per cent. elongation (average of eight results). One further attempt was made to overcome this difficulty with horizontal run test-bars by using the star gate bar shown in Fig. 8. In this bar an attempt is made to equalise the temperatures at each end of the test-bar by running both ends simultaneously. The tensile strengths obtained were fairly consistent, but much lower than those earlier obtained, as illustrated by the data in Table II. The first bars poured were made in green moulds with rather large cross-runners, and it was likely that the runners were not completely filled during pouring. Further bars were made in green

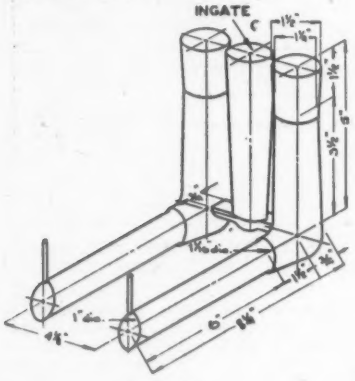


FIG. 4.—2ND MODIFIED BAR.

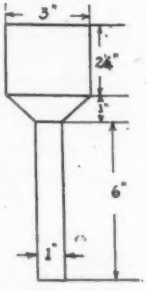


FIG. 5.—TOP POURED D.T.D. BAR.

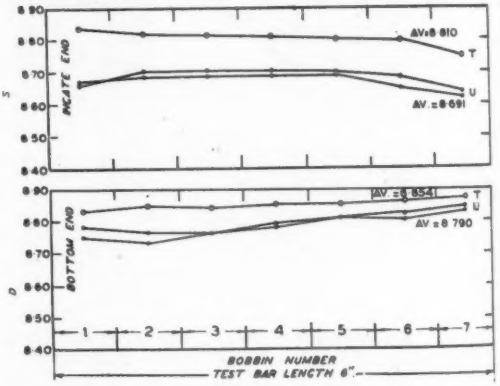


FIG. 6.—VARIATIONS IN DENSITY ALONG DIFFERENT TYPES OF BARS.

TABLE V.—*Comparison of Tensile Properties of D.T.D. and Keel Bars in Tin Bronze.*

Nominal composition of alloy. Per cent.	Pouring temperature, deg. C.	D.T.D. Bar. Density, gm./c.c.	D.T.D. Bar. U.T.S., tons per sq. in.	D.T.D. Bar. E per cent., $4\sqrt{A}$.	Keel Bar. Density, gm./c.c.	Keel Bar. U.T.S., tons per sq. in.	Keel Bar. E per cent., $4\sqrt{A}$.
90/10 deoxidised with 0.07 per cent. P. Degassed	1,120	8.85	17.9	17	8.79	22.6	46
88/8/4 gunmetal. Slightly gassy ..	1,180	8.72	15.4	12	8.67	13.8	11
85/5/5/5 leaded gunmetal. Degassed..	1,180	8.80	13.2	19	8.80	14.3	22

* The keel bar was the U.S. Navy bar consisting of two keels 1 in. by 2 in. deep, separated by 1½ in. with a common feeder 2 in. deep over the whole length of the keels.

moulds, but with smaller runners and, although the properties were improved slightly, they were well below the strengths previously obtained. Dried moulds gave substantially better results, although still lower than earlier figures obtained.

The D.T.D. Bar

Horizontal test-bars were then abandoned and extensive tests were made with the D.T.D. bar used universally by the light alloys industry, which, as earlier tests showed, gave very high-density bars from degassed material. This bar has been used for the greater part of the Association's investigation on bronze castings. It has proved extremely satisfactory, giving consistent high strengths when degassed material was used, but being very sensitive to the presence of gas. The average results obtained for various degassed bronzes are indicated in Table III. The highest densities and best strengths are obtained using low strength. Feeding is evidently not good enough for these alloys.

A comparison of D.T.D. and keel bars has also been done on bronzes, with the results shown in Table V. The tensile test results for degassed phosphor-bronze and leaded gunmetal were rather better using the keel bar, but the figures for the D.T.D. bars are lower than are usually obtained, and on a large number of bars there would probably be little difference between the two types. The results for the slightly gassy gunmetal indicate that the keel bar is no les sensitive to gas than the D.T.D. bar.

It will be appreciated that the foregoing results do not represent a systematic investigation on test-bars for non-ferrous metals, or even for tin bronzes. Nevertheless, these few results of tests made from time to time on various forms of test-bar illustrate the need for standardisation, and give some indication of the form likely to be satisfactory.

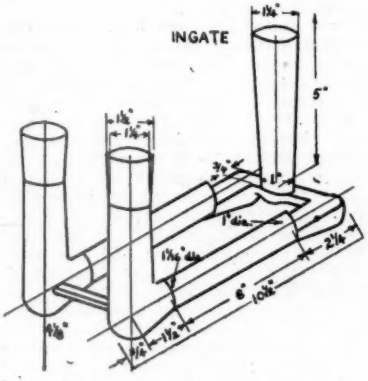


FIG. 7.—MODIFICATION DESIGNED TO ELIMINATE POROSITY.

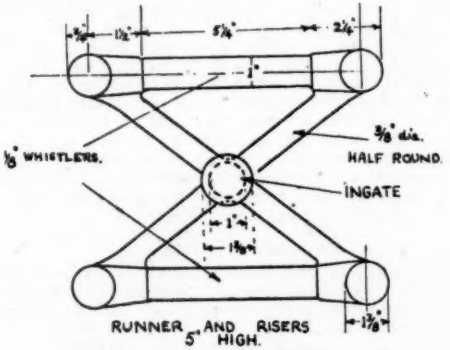


FIG. 8.—STAR GATE BAR.

pouring temperatures, and in these and in other bronzes tested the strengths improve with increasing density, although occasionally high-density bars have unduly low strengths.

Thus the bar satisfies the two main conditions required and, incidentally, it is very satisfactory in the other respects mentioned, namely, the mould is very easy to make and the amount of metal used for a casting is comparatively small (5¼ lbs.). These features make the test-bar attractive for general use, but it has not been found satisfactory for the so-called high shrinkage alloys, namely, manganese bronzes and aluminium bronzes. For example, a few tests comparing the D.T.D. bar with keel bars gave the results in Table IV.

The keel bars were found to be entirely free from porosity, but the D.T.D. bars contained small amounts of shrinkage porosity, which caused serious loss of

It appears that some form of keel bar providing feed over the whole, or at least the greater part, of the test-bar length will be necessary to ensure satisfactory feeding. A test-bar diameter of 1 in. seems a suitable standard size, since the rate of cooling in such a section is of the same order as that in a ½-in. thick plate, which is a fairly average value for the section of non-ferrous castings. The 1-in. bar may therefore be expected to have a micro- and macrostructure fairly representative of the average casting, and may be expected to be sufficiently sensitive to the effects of gas, if any is present.

The remaining considerations are the weight of metal required per bar and the time and labour required in casting, machining and testing. Bearing these considerations in mind, the most useful universal test-piece is likely to be a bar with some of the features of the Crown test-bar advocated in the United States and Canada for tin bronzes. In this bar a shaped specimen is fed through necks extending over the

(*Concluded on page* 163.)

IS THE CHEMIST NECESSARY IN THE FOUNDRY ?*

By J. Stott.

Whenever meetings of foundrymen are held, to hear and to discuss foundry problems, the position of the works' chemist seldom, if ever, enters the discussion, unless thrust upon it by the purposeful chemist himself.

Moulding technique, coremaking, melting practice, and the hundred and one other items which go to produce the casting, be it good or bad, are brought forth with a sense of pride of having attempted something worth while (or otherwise), each section giving its own views and opinions, and again the chemist is overlooked, or taken for granted.

Who are these people, then, who are working behind the scenes, and who are usually hinted at as being the technical staff? To the old school, they are expensive luxuries which can be well discarded. Their castings have always been good, being brought into the world through the light of bitter experience. Granted, some of these craftsmen have produced something worth while, even if the castings, judged by modern standards, could have been improved. They have laid down the foundations of present-day foundry practice, and it is on these that modern foundries are built. They were not scientifically trained, and rule-of-thumb methods were the order of the day. Thus the chemist was looked upon with distrust, and his work, however well intended, was produced with a certain amount of misgiving.

Modern Notions

What, then, do the moderns think of their works' chemist? Their foundries are equipped with modern melting appliances, sand-preparation plants, coupled with machine moulding or some other devices for mechanical production of moulds. Output with quality is the keynote, and coupled with this comes uniformity, which is the object of the mechanised foundry. From this angle, then, the chemist reigns supreme—or does he? True, he can check a thousand and one things to help in the attainment of uniformity. He can examine faulty castings, and so confirm his superior's opinions as to cause of failure. The modern foundry manager has had a quite different training from the old-type foundryman. Did he not, nine times out of ten, start his embryo foundry existence amidst the beakers and test-tubes of the laboratory, graduating from there through the various stages of foundry life, coupled with technical training at some institute? Thus a new aspect arises; whereas the old-time foundryman could not appreciate the chemist, the modern foundryman knows full well the capabilities, and also the limitations of the chemist. He should know in what way he can help, and also be able to lend a guiding hand to his colleague. This latter combination is the ideal way, and the chemist, then, should not be looked upon as a necessary evil, but a healthy and useful partner in the foundry organisation. On the other hand, it is quite easy for the foundry manager to be somewhat superior to his chemist, due to the fact that, as has already been mentioned, he knows his limitations, and thus uses him only as a last resort.

Metal Control

What, then, is the position of the laboratory and its staff? They can control or mislead the foundry by their work, and probably some foundries do at times get misled. Unlike steelfoundries, where the chemist can control metal production, in grey-iron manufacture, the metal composition control must necessarily come first, as, once the melting has started, the metal must be taken, and the castings made and then checked for composition. It is obvious, then, that no correction can be applied during the melting operation, particularly with the cupola, and thus some arbitrary test must be installed such as the chill, and in some cases a fluidity test.

It has been stated by some foundrymen, however misguided they may be, that, given a supply of pig-iron of uniform composition—most pig-iron manufacturers give guaranteed analyses and pedigrees of their offspring—and their own melting technique, good castings can be produced using chill tests to check metal uniformity. Thus the chemist is not necessary, and many foundries probably look upon this as being true. What, then, is the case when things go wrong, and foundries, however well managed, have their off days, when scrap percentages climb and the machine shops complain about chilled castings? Surely, then, the chemist becomes a necessity, or will trial and error suffice? Pig-iron, even before the war, could vary in composition from that given on the pedigree card. Coke varies, and so can a thousand and one things which affect that uniformity of production which is essential for a progressive concern. The chemist, by meticulously checking and assessing products and raw materials, is helping to attain that goal. Certainly he is not entirely responsible for the production of all good castings, but he does help.

Pig-iron Contamination

Under present-day conditions, the chemist becomes more and more valuable. Substitute materials, shortages of essential supplies, make the foundryman's life all but a bed of roses. Specifications must still be met in spite of concessions, greater output is needed in order that the war may be won quickly, and economically. It is then obvious that the foundry, with chemists on its staff, will see its pitfalls, and be able to cope with them. Pig-iron that once was produced from good ores is now made partly from steel scrap of varying composition. Nickel, which was a rarity in pig-iron, is now present, along with chromium, in several brands of pig-iron. Some specifications are not affected; others stipulate the absence or set a low limit on alloys, and thus pig-iron must be systematically checked.

(*Continued on page* 168.)

* A Paper read before the West Riding Branch of the Institute of British Foundrymen, Mr. L. Turner presiding.

PRODUCING SOUND MAGNESIUM CASTINGS

By J. HAYWOOD

Flux Inclusions: Porosity and Gating Systems are discussed

By far the most common faults met with in magnesium castings are porosity, flux and oxide inclusions. These not only cause the castings to be rejected when subjected to pressure test, but probably cause premature failure of the component when in service due to a local reduction in section with a corresponding decrease in strength. Various ways and means for overcoming these defects have been suggested from time to time, some helping considerably, others only partially. A procedure has now been found whereby sound castings can be produced free from these defects.

Flux Inclusions

These are usually present in the casting mainly as a result of poor melting practice. The following procedure has been found very successful for the melting and cleaning of the metal prior to casting. A cast or pressed mild steel crucible is used in a gas- or oil-fired furnace. Two fluxes are used during melting, low melting-point flux "A" and high melting-point flux "B."

FIG. 1.—OXIDE INCLUSIONS.

(*a*) *Initial Melting.*—A sprinkle of flux "A" is placed on the bottom of the crucible prior to charging any metal. As the metal progressively melts, more flux is added until sufficient molten metal has been obtained. The amount of flux used during this stage is about 2 per cent. of the total weight of metal charged. The temperature of the metal is then raised to 730 to 750 deg. C. ready for the refining operation.

(*b*) *Refining.*—The flux having a lower specific gravity than the metal, and thus remaining over its surface, is now removed by means of a dredging tool. A further 2 per cent. of clean flux "A" is now sprinkled over the surface and then stirred into the metal vigorously for about 1 min., during which period the refining takes place. Any oxide present combines with the flux to form a dross which sinks to the bottom of the crucible. The sides of the crucible are then well scraped, and the dross, etc., removed from the bottom, together with any dirt or excess flux remaining on the surface of the metal. The ideal to aim at is just a small quantity of flux remaining on the surface after refining. If the surface is comparatively clear, then more flux should be added and the stirring and dredging operations repeated. After cleaning the last remains of this flux from the surface, 2 per cent. of the higher melting-point flux "B" is sprinkled over the surface. This fuses together to form an efficient covering, thus preventing any further oxidation taking place.

(*c*) *Super Heating.*—The super heating or grain refining operation is then carried out, the temperature of the metal being raised to 880 to 900 deg. C. and held there for 10 to 15 mins. The crucible is now removed from the furnace, and when the temperature has fallen to about 20 to 40 deg. C. above the casting temperature, the crust of flux is broken and removed, care being taken to remove the last trace from around the edges. Sulphur is then sprinkled over the surface at intervals, to minimise oxidation. The metal is now ready for casting.

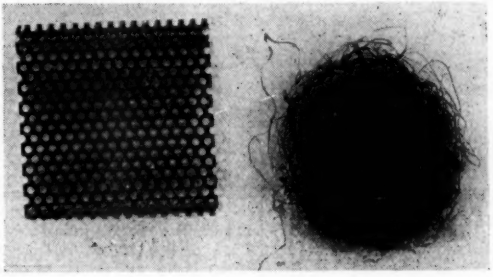


FIG. 2.—PERFORATED PLATES AND STEEL WOOL USED FOR "FILTERING" MAGNESIUM CASTINGS.

It will be seen that meticulous care must be taken during the melting operations, and all traces of flux should be removed as far as possible before any attempt is made to cast the metal. This is the first essential step in the production of sound magnesium castings—*clean metal.*

Porosity and Oxide Inclusions

These are discussed jointly, as their presence in magnesium castings are closely related, being mainly due to incorrect moulding and running technique.

Producing Sound Magnesium Castings

Porosity in magnesium castings differs from the usual type of porosity met with in aluminium alloys, in that instead of being due to gas adsorption it is caused by shrinkage of the eutectic mixture at the grain boundaries, leaving voids of varying magnitudes. The more massive type is usually due to: (1) Area of ingates too small, restricting the flow of metal; (2) ingates improperly placed, and (3) insufficient and improperly placed risers.

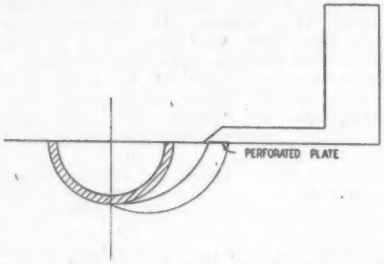


FIG. 3.—SHOWING HORN AND DOWN GATES.

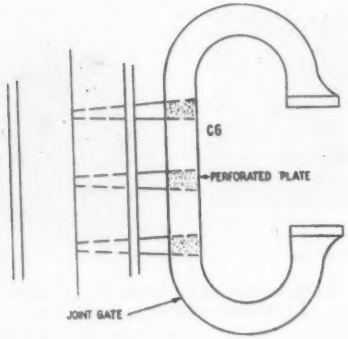


FIG. 4.—SHOWING PERFORATED PLATES AND CROSS GATE.

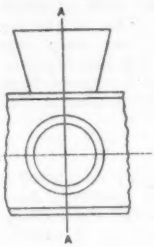
Micro-porosity of the smaller type is usually present:—(1) Where there is a rapid change of section; (2) near an improperly designed ingate, and (3) or may be due to turbulence caused during the filling of the mould.

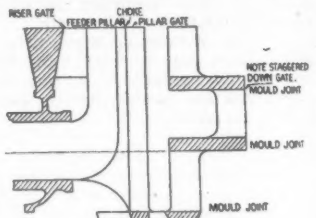
Oxide inclusions are usually present as very small flakes, which form planes of weakness, and on a fractured face (Fig. 1) show as brown or blue facets. The presence of these oxide inclusions may be due to one of two reasons:—(1) It is carried into the mould from the surface of the metal, or (2) turbulence caused during casting.

Gating and Feeding

Turbulence of the metal is the most important factor to be avoided when casting magnesium. The first step must be the use of numerous small ingates rather than a few heavy ones. Care must be taken, however, not to have them too thin, otherwise the flow of metal is restricted. Also, several thin rectangular down sprues are used rather than one large one, being placed together under the one runner box. This permits rapid filling of the down sprues and runner-box, and so avoids sucking air or oxide into the mould.

The use of strainers, *e.g.*, perforated steel plate, steel wool, etc., placed in the gating systems as near to the ingates as practicable, has been found neces-





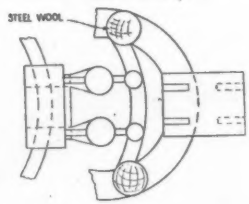


FIG. 5.—SECTION OF CASTING WITH RISER.

FIG. 6.—SECTION AS AT A.—A SHOWING ONE PILLAR GATE INTO PORT AND STAGGERED DOWN GATE.

FIG. 7.—SHOWING TWO PILLAR GATES CONNECTED TO BOTTOM RUNNER RING.

sary to produce clean sound castings. The most satisfactory type of perforated plate is made by 28 G. sheet, and has 64 holes per sq. in., whilst the steel wool should be a semi-coarse grade (Fig. 2).

Steel wool has been, and is, the most important material used, but there is plenty of scope for the use of perforated plate. One advantage the perforated plate has over the steel wool is that the measure of restriction it imparts and its capacity for filtering can be controlled fairly accurately by using the same size of plate in the ingates in each mould. The steel wool placed in the ingates offers better filtering facilities, but may vary in density from mould to mould, thus causing varying rates of restriction on the flow of metal, with the probability of mis-run castings. While strainers minimise turbulence, it is mainly in the selection of size and type of ingates

where the main advantage is gained, as inferior gating systems do not allow an unrestricted and progressive flow of the metal.

The metal should be directed through a section without obstructions from core or cods. It is also essential that the metal should enter the mould at the lowest possible and practical point and not from the top or middle joint of the mould. Only on shallow castings, where the design permits a smooth entry, can running from the top joint be considered with a chance of success. It can seldom be carried out on major type castings or castings with any depth.

Horn gates, incorporating the perforated plate strainer, can be used very successfully on many types of small castings. Fig. 3 shows the horn gates with perforated plate, used in the production of thin-section pipes. The plates are placed at the top of the horns (see Fig. 4), and in this position hold back any particles of flux trapped in the metal and any oxide created in the initial stage of pouring. It will be noticed (Fig. 4) the joint gate adjoining the cross-gate has been designed to allow a smooth flow of metal into the mould. All gates must be cut smooth with avoidance of sharp changes in direction, otherwise turbulence ensues, with the resultant oxide inclusions.

Bottom gating, although mainly successful in producing oxide and flux-free castings, does not always produce sound major-type castings. This is quite understandable, as cold metal is always at the top of the mould and hot metal at the bottom—the reverse to the conditions required. Because of the low specific heat and latent heat of fusion, magnesium solidifies very rapidly, and this change from liquid to solid is so rapid that the actual amount of feeding, unless very close to the riser, is almost negligible. This leads to intergranular porosity as explained earlier. Thus the problem of obtaining progressive feed to allow risers, feeders, etc., to function correctly must be overcome. This cannot be accomplished, as stated previously, by top running.

It is possible by the use of pillar-type gates and bottom running (see Fig. 6) to get progressive feed without turbulence. The gates are made up of pillars joined with choke pieces which run the whole depth of the mould. The running area of the choke is always less than the area of the pillar gate. This ensures the metal entering the mould in a tranquil manner and forces the hot metal to the top of the mould. The pillar-gate emanates from the bottom joint of the mould, where it is attached to the bottom runner ring (Fig. 7). This ensures a levelling-up of the metal before it enters the back pillar-gate. The feeder-pillar near the mould entry is made larger in section than the particular section of casting to which it is connected, to obtain the necessary amount of feed. The pillars can be extended through the top part of the mould and joined to the risers or feeders with gates (Fig. 7). This prevents excessive metal passing through the mould and ensures hot metal in the feeders. The initial downgates are rectangular in shape and staggered at the joints wherever possible

(*Continued at foot of next column.*)

TEST-BARS FOR BRONZE CASTINGS

(*Concluded from page* 159.)

length of the specimen with the exception of the middle gauge length portion, with a massive feeder over the whole length of the bar. In its present form the Crown bar is open to several criticisms. The feeder is narrow and deep and only one bar is fed from it. The necks from the feeder to the test-piece are only $\frac{3}{4}$ in. thick and would probably be too thin to allow perfect feeding of some alloys.

A more economic arrangement is shown in Fig. 9. This test-bar form has not been tested yet, but it seems likely to meet most requirements. The feeding

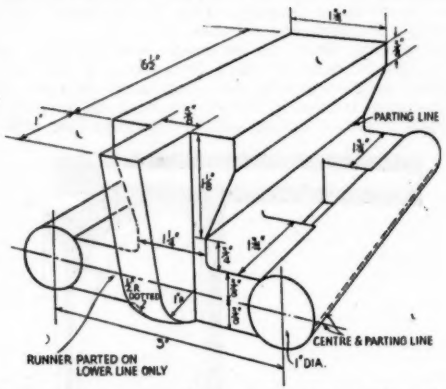


FIG. 9.—SUGGESTED FORM OF UNIVERSAL TEST BAR.

necks are thick and extend over more than half the length of the bar, but the arrangement of test-bars and feeder is such that the specimens can be fairly easily detached. The feeder is shallow and thick, which makes for good feeding efficiency. The whole casting has such small depth that direct pouring down the slot section shown at one end of the feeder would probably be practicable even with alloys which dross badly during pouring. This test-bar form, however, is quite a tentative suggestion based on consideration of the variety of forms in use at present. Whether this or some alternative form is adopted, this Institute could render a valuable service to the industry by sponsoring investigations which would lead to an accepted standard test-bar.

(*Continued from previous column.*)

(Fig. 6), and connected to the bottom ring gate. Steel wool placed in front of the ingate pillar (Fig. 7) and used in conjunction with a choke ensures a casting free from flux and oxide inclusions. Castings of varying heights up to 14 in. have been successfully cast using this system of running.

CASTING REQUIREMENTS

By A. R. P. Warden

Foundries quite frequently receive orders for billets of cast iron, a recent case calling for:—

1 7½ in. dia. and 2½ in. thick.
3 7½ in. dia. and 2 in. thick.
3 7½ in. dia. and 3 in. thick.
3 9½ in. dia. and 2 in. thick.
3 9½ in. dia. and 3 in. thick.

These may be for packing pieces and be buried in concrete or may have a considerable amount of machining done on them, but on the order nothing is said about their purpose. This is a mistake, as the writer will endeavour to show.

A packing piece can be made by a moulder with little skill or may be made by a boy. If the above require machining all over and also require considerable quantities of metal removing by turning or milling, a special gating and feeding technique will be

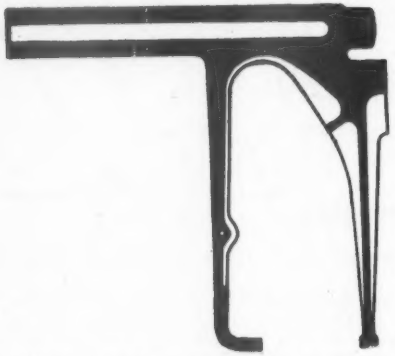


Fig. A.—A Part Section of Large Casting Showing Rod of Metal Cast Thereon over 13 Ft. Long and 18 Ins. Diameter. (Machin and Oldham.)

required. There would be little technical difficulty in getting forged steel billets suitable for machining for the latter, but if the patterns were sent to a steel-foundry for castings, large feeding heads would be cast on the top and afterwards cut off by oxy-acetylene.

In certain circumstances, but not to the same degree, large risers are required for cast iron. The writer remembers a 9-in. dia. block, 9 in. long, in cast iron, which was cast 18 in. long to get the solidity necessary for use as a heat reservoir.

An extract from a Paper* is included showing a casting required in steel and the measures necessary to obtain a solid casting. The specification for this casting was that a 9-in. dia. hole or core had to be

(*Continued at foot of next column.*)

VERMICULITE

A huge new War Department building in Washington will be protected from incendiary bombs by vermiculite, a mineral which is becoming an important factor in modern warfare. Vermiculite has already been supplied to make bombproof decks for military installations. Because of these uses and the rapid discovery of other uses, vermiculite production in the United States is proceeding at a record rate, with new deposits being opened.

Vermiculite has the peculiar quality of exfoliation with intense heat. Treated thus, the expansion is so great that untreated mineral weighing 100 lbs. per cub. ft. will weigh only 6 to 20 lbs. per cub. ft. after heating. It is also highly fire-resistant, and mixed with concrete provides both lightness and insulation. When vermiculite is used as an aggregate in concrete, the pre-cast slabs can be sawed, nailed, and worked much like wood.

Because of its lightness when treated, vermiculite is also being used for packing shells and bombs for shipment to the front and for filling life preservers as a substitute for cork. Experiments are now under way to use it as a filter for aviation spirit to replace the various earths now scarce.

Potential Uses

The peculiar properties of vermiculite indicate many widespread peacetime uses. Experiments have been made in using light-weight concrete for prefabricated houses, and its use as an insulator was already under way before the war. It can also be used in making heat-insulating brick and in fireproof plasters.

The lubricating qualities of vermiculite are comparable with those of flake graphite. Used as an extender for aluminium paints, it increases coverage by 25 per cent. and is now being used both as a coolant and lubricating agent in motors and transmissions of motor-cars. Other uses are being constantly reported with many interesting possibilities, especially in construction.

(*Continued from previous column.*)

drilled or cast down the rod for lightening purposes. The only safe method in the foundry to make this a sound casting was to cast the rod solid so that feed could be supplied to adjoining thick sections. This method was carried out and a feeder 13 ft. 6 in. long, 18 in. dia., resulted in a perfect casting. The above should make clear the necessity for stating requirements, to avoid unnecessary refinements when making packing blocks or to ensure necessary precautions when the type of finished article requires it.

* This extract is in the form of a part section drawing, of which is reproduced herewith. A reference in the text explains that: "A cheaper casting could have been produced by using a core, but shrinkage defects would have been almost certain to develop in the heavy junctions." The drawing and quotations are taken from a Paper entitled "Castings," by Machin and Oldham, presented to the Institute of British Foundrymen in 1935.

CUPOLA OPERATION AND CONTROL

MR. TUCKER'S PAPER AMPLIFIED

The proper way to melt steel and the correct use of coke and instrument calibration are explained

Mr. Tucker's Paper, which was printed in our last issue, was followed by a particularly informative discussion. The following is a report of the meeting:—

MR. J. ROXBURGH said that he had been interested in the considerations which the lecturer had given to the question of cupola air supply, and to note that he had emphasised the question of the volume of the air and not blast pressure. He quite agreed with Mr. Tucker that the flared type of tuyere is preferable to any other type which he had used. The question of the number of rows of tuyeres is a subject which had led to much controversy, and personal experience was very similar to that of Mr. Tucker. He had been content with two rows. He asked the author to outline the conditions necessary for the melting of charges containing their underlying theory.

With regard to the use of coke as fuel, an important point was that the coke should be able to sustain the weight of the material above it, and personal experience was better results were had when using large sized coke for large cupolas. The author had omitted to include the question of wet coke, which some people, unlike the speaker, thought was beneficial.

Tuyere Design

MR. TUCKER, in reply, said there was far too much theory and far too much calculation in the foundry practice, and there was no one so theoretical as the practical cupola operator. In connection with the design of tuyeres, he believed Mr. Roxburgh's experience had been very similar to his own. The two rows of tuyeres should be about 12 in. apart. The melting of steel involved the following desiderata. Steel was a material which had a melting point of 1,500 deg. C., and it took a certain time to get down to the top of the bed. It absorbed carbon and melted as it did this. Its melting point was then reduced. Both high carbon and mild steel could be melted in the cupola. Unfortunately, the quality of coke had deteriorated and this influenced the nature of the surface of the coke.

Control of Carbon Pick-up

Carbon pick up was not regular, for poor coke would enable the steel to pick up more carbon. If all mild steel was melted in the cupola, one would get something like 2.5 per cent. carbon. For an ordinary steel charge mixed with anything up to 50 to 60 per cent. steel, there must be an alteration in cupola practice to achieve success. If the cupola was working properly and producing hot metal before starting to use steel mixes, then, providing a suitable mixture was incorporated, the height of the coke bed must be maintained, 6 in. being the ideal.

The weight of the metal charge would be slightly reduced to balance the carbon absorbed into the steel. Steel would absorb carbon, and therefore one would think a little extra coke should be put on the cupola, but if the coke split had been made, the better method was not to increase the coke, but to decrease the size of the iron charge. This kept the bed-height constant. If a little extra temperature was required, there were two ways of doing it. The coke split should not be decreased, but the bed height can be increased by charging extra coke and blowing in more air. The air just combusted the coke. What happened in most cupolas was that the bed was being burned. In one case one obtained excessive carbon and in the other case oxidised metal. The best method, however, was to measure everything and keep them constant; use a suitable sort of steel and then decrease the iron charge and not the coke. D. J. Reese (loc. cit.) gave detailed information as to this.

Influence of Wet Coke

Referring to coke size, of course large coke was large because it was strong. It had to be strong as it was often badly knocked about during transit. As to the use of wet coke, there must be a certain amount of moisture in the cupola. If one used perfectly dry coke, it just would not burn. The water which was evaporated into the cupola would reduce the temperature of the effluent gases. Wetting would do no good and reduce the preheat available for preheating the metal; thus the use of wet coke was not to be recommended. It was deceptive if coke was weighed when it was wet, when, of course, it naturally weighed heavier than when dry. There was usually in this country sufficient moisture in the atmosphere. The charging of a cupola should be effected with discrimination, *i.e.*, the steel should be charged with the scrap and the scrap with the pig-iron; a good temperature should be ensured and the whole charge should descend simultaneously.

Diameter and Tuyere Disposal

MR. F. G. BUTTERS said he had tried to follow the Paper, which he thought contained much controversial matter. For instance, the single row of tuyeres as against double, three or four rows. Broadly speaking, the size of the cupola should determine this point. One would not think of putting a double row of tuyeres around a cupolette, but one would get a better result in a cupola of 42 in. inside diameter with a

Cupola Operation and Control

double row of tuyeres. Tuyeres should be flared as much as possible. If one insisted that the only aim was to introduce air, then naturally one big row of tuyeres which were flared so as to join each other would be adequate, even in a big cupola. However, this point was quite controversial. Commenting upon the 48 in. cupola which Mr. Tucker said should have 128 lbs. as the coke split, he noted that at a 10:1 ratio, the metal charge would be about half a ton. If that was American practice, it did not conform to the general practice in this country. He also had read about American cupola practice, and noted that Dwyer stated that $\frac{1}{10}$ of the melting rate of the cupola was a good guide. He favoured Dwyer's practice rather than that quoted by the author.

The variations in the depths of the bed were figures which were quoted from a Paper by Reese (A.F.A.), and they varied from 27 in. to 60 in. above the tuyeres.

Now, if anyone who was not used to cupola practice and was learning from a textbook, he would gather from Hurst's work, "Melting Cast Iron in the Cupola," that the coke bed should reach 18 in. above the tuyeres. Personal experience with this practice was that the metal came down in about 4 min., but was very dull; by raising the bed to 30 in. the result was satisfactory, the metal then coming down in 9 min. Added information was required as to the depth of coke bed for use with ordinary cupola.

He had available about 10 tons of steel clippings, 2 in. by 1 in. by $\frac{1}{4}$ in. thick. He had not so far used them, and asked the author whether they could be used to advantage as part of the cupola charge.

Factors for Cupola Control

In reply MR. TUCKER agreed that the size of the cupola did influence the choice of the number of rows of tuyeres, yet both types of furnace could be made to give excellent results. He considered his cupola practice was pretty good; he had a 54 in. cupola, carrying a 36 in. bed above a single row of tuyeres. The cupola was a symmetrical body, and when the size was doubled, the size of all the dimensions should also be doubled. The coke split should be about 6 in. high, and so on. One should also theoretically double each dimension of the fuel. It stood to reason that the same reactions were proceeding in a large cupola. There was much to be said in favour of Reese's views as to the height of bed. It could be laid down that a cupola demanded a certain bed height. If steel was being used, a little more bed height was required. It was important to realise that bed height could be varied. Mr. Butters mentioned the use of steel clippings. He recommended the making up of a higher bed in the cupola when melting such clippings, and the use of very low blast rate. By so doing good results should follow, a fact which illustrates the versatility of the cupola. Incidentally the best way to get 5 tons out of a 10-ton cupola is to run it 5 min. and stop it 5 min. Regarding the weight of metal charge, the actual figures were for a 48 in. cupola, 128 lbs. coke charge, and a ratio of 10:1, that made 1,280 lbs. of metal. This was small for a 48 in. cupola. When one realised that with a 54 in. cupola, a 211 lbs. coke charge, there was a 10:1 ratio, that was 2,110 lbs. of metal; these figures for a 48 in. cupola did seem rather low. They were perhaps better suited for a 36 in. cupola. The situation, he admitted, required checking, which he would do.

Instrument Maintenance

MR. C. A. PAYNE, whilst endorsing the remarks concerning measuring instruments in cupola operation, including pyrometers, said that to follow the current trend to the extreme would result in such a mass of instruments that so much time would be needed for their maintenance that the cupola itself would be neglected. It was most important, however, that the readings of such instruments were not considered as absolute values. Thus when a good run had been achieved, then, knowing the readings, subsequent operation with these readings would, if other conditions were held equally constant, produce equally good results. Particularly was this so with optical pyrometers, for unless all the corrections involved were applied, readings taken under differing conditions could not be compared on an absolute basis. They were, however, extremely useful if these limitations were realised. His firm had a fan which was capable of delivery against a pressure slightly higher than that normally obtained in operation. On increasing the resistance to the blast (by the blast-gate, or by changing cupola conditions) there was a noticeable rise in the water-gauge reading. It should be clear, however, that this gauge was connected to the blast main, not to the wind belt.

With auxiliary tuyeres, where there was a simple type of mix, there seemed to be a great deal in their favour. Where there were steel-bearing charges, or, more important, where there were a number of different types of charge in the same run, did it increase the difficulties of dilution? Was it possible to separate effectively one type of charge from another, subsequent, different charge?

Coke Control

Recently his firm purchased a standard Pitot tube with which to check the volume meters. He asked for Mr. Tucker's advice as to how to go about this, and from his experience indicate the probable snags. In the various data shown, the carbon content of the coke was presumably the fixed carbon and not the total percentage of carbonaceous matter present. He had recently a great deal of large coke available; yet he had had a great deal of trouble with excessive crushing. Would the author give his opinion on the amount of fixed carbon and of volatile matter desirable? Finally, he had had some difficulties with very small cupolas (18 to 20 in. dia.). From calculations a coke split and corresponding charge weight was obtained; another person tried it out in practice and found that the best results were obtained by just halving the calculated figures.

With the Pitot tube he used a differential manometer, and he wished to determine the mean velocity, thus getting the volume from the known main diameter. There was an increase of 2 to 3 in. on the water gauge, which generally showed about 20 in. of water. When charging steel, this went on the coke first, towards the sides, then the pig-iron; finally, the return scrap on top and in the centre. If there be any carburisation, then the steel would receive it. Furthermore, the melting zone was not flat, but like an inverted cone, and thus the steel had a chance to get to the melting zone first. Resulting from the need for black-out (using a water-sprayed cowl) there was a great deal of water going down inside the cupola. What effect was to be expected? On one occasion, when there was a very bad leak in the water pipe when the blast was shut off for slagging, and through an opened tuyere cover there came a bright yellow flame about 4 ft. long which lasted nearly 2 min. This was presumably water-gas, and made one realise how much water could get down the cupola lining.

Checking a Volume Meter

MR. TUCKER agreed with Mr. Payne that the efficient maintenance of certain instruments was essential. He would use a standard Pitot tube to check volume meters, but there must be a straight main. Secondly, the standard Pitot tube would have been calibrated for certain conditions and the calculations from these conditions were not very easy. The Pitot tube formula was accurate to about 5 per cent. During the test, measure the water content of the inlet air blower and make sure that a correction is made; also be certain that everything is clean. The only way of standardising a Pitot tube was to conform to the exact conditions on which it was going to work. This could be done by the N.P.L. under these conditions, and it would give quite a good reading, but perhaps not the exact figure—probably within 5 per cent. One must not forget that the pressure difference depended on an accurate knowledge of the density of the gas. The air density would vary with its pressure and with its water content. These figures must be checked before starting. Mr. Payne mentioned that he had a fan which tended to give a higher pressure than he actually obtained in the cupola. It must be remembered that power cost money, and if Mr. Payne was running his fan at a lower rating, he was probably losing money. There was, however, a slight loss of efficiency due to non-uniformity.

Mr. Payne mentioned that he had coke containing volatile matter. What was volatile matter doing there? It was an indication of an application of the carbonising process. Semi-coke was very weak and easily crushed, but it had high combustion value.

He personally was always satisfied with 1¼ to 2 per cent. volatile, as that gave a coke which was not too green and not over-coked. He did not worry about the ash content or sulphur content of coke, but he did the volatile matter. Did Mr. Payne make any adjustment to the size of his coke? He thought that with 2 in. coke, about a 4 in. split was needed. It might have made a difference if Mr. Payne had used 4 in. coke in a cupola of that size. The smaller the cupola, the more sensitive it was to the difference in the size of the fuel.

Bed Height and Auxiliary Tuyeres

As to the use of auxiliary tuyeres with the different types of charge, he was inclined to think it was beneficial. The position was the most important thing, in other words, the height of the bed. The melting of steel and light cast iron scrap together was bound to lead to a certain amount of trouble, because their melting rates were so different. The auxiliary tuyeres would increase the depth of the melting zone. The use of excessively large auxiliary tuyeres would not help, but would induce compositional irregularities. For that reason he preferred to put the high steel charges on first and the low steel charges on afterwards.

Regarding the question of water, this depended on how much was dropping in. The rain could come in at the top of the cupola, but it evaporated before it could cool the metal. If there was a bad leak the water could go far, and it was surprising how much water could flow along really hot refractory linings. In any case, it was bad practice to allow water to enter a furnace.

Vote of Thanks

After MR. R. H. BUCKLAND had voiced the obvious appreciation of the members, MR. G. L. HARBACH, in seconding, raised a few points of technical interest. He said the figures quoted for the depth of bed charges always struck him as being rather high. With a 48-in. dia. cupola one could run at the rather low melting rate of 6 tons per hr. with the bed only 24 in. above the tuyeres, plus split coke, and obtain hot metal from the first tap. On the question of the course of the blast in the cupola and the melting zone, the first slide indicated the air going more or less across the cupola in line with the tuyeres, whereas the line of least resistance would be around the walls, resulting in a melting zone higher at the edges than at the centre. It was probable that this inverted cone shape was at least as high as the radius of the cupola when melting at a low rate and considerably higher when melting at maximum rate.

Metal analyses tended to support this view, as they showed that more than one charge melted at the same time. As the bed coke must be higher than the highest part of the melting zone, the American figures were most likely to allow for the highest possible melting rate. This point connected up with superheat, for, as it was not possible to melt at a temperature higher than the melting point of the components of the charge, superheat would depend on the depth of incandescent coke through which the liquid drops of metal fell. Would Mr. Tucker agree with these opinions?

Regarding the melting of steel in the cupola, it was generally accepted that the melting point was lowered

(*Continued on page* 168.)

CUPOLA OPERATION AND CONTROL

(*Concluded from page* 167.)

by carburisation, but, according to Kain, partially melted steel recovered from a cupola "drop" showed no carbon pick-up. From this it was probable that the temperature in the melting zone reached the melting point of steel; he asked for Mr. Tucker's opinion on this point.

Mr. Tucker's Reply

After acknowledging the vote of thanks, MR. TUCKER said there was a possibility that there was no penetration of the blast into the bed, because it became obstructed by the coke. One obtained the penetration because of the momentum of the blast. It should be fairly uniform by the time it had zig-zagged about the coke bed.

Regarding the higher temperature of high steel mixes, he agreed with Mr. Harbach. The rate of melting of the furnace depended upon the amount of heat that communicated. He was prepared to agree that the carburising of a steel was very low. Remember how long it took to heat a bar for case-hardening, or how quickly one could carburise a piece of mild steel in a ladle of molten metal. No doubt this high rate of carburisation only took place in the molten state. It was probably bound up with the melting conditions, due to using a good quality coke.

IS THE CHEMIST NECESSARY IN THE FOUNDRY?

(*Concluded from page* 160.)

With the further rapid extension of the use of high-duty cast irons, on the grounds of economy, rigorous control must be placed on alloy additions. It is unforgivable in these times to scrap castings, and thus the chemist is playing an important role in watching and reporting variations in composition. What, then, of the future? It is certain that the chemist's future is assured, and as cast iron will play its part in the "New World" even, it is hoped, in greater measure, so will the chemist's work increase. Cast iron's development from 8 tons tensile to 40 to 50 tons is a fitting tribute to foundry metallurgists, and the chemist can be classed with these pioneers, if only in a small way.

Industrial Diamonds

A research department has recently been established by the Diamond Trading Company, Limited, whose London office is at 32/34, Holborn Viaduct, E.C. The department is under the management of Mr. Paul Grodzinski, and is engaged in investigations into the properties of diamonds, their preparation for use and, in particular, their application in industry both present and potential. An extensive technical library and an information bureau are available to readers of THE FOUNDRY TRADE JOURNAL.

NEWS IN BRIEF

THE FIRST MEETING of the South African Association of Production Engineers was held in Johannesburg in January.

EXPANSION of the industrial salvage groups scheme is making good progress. There are now more than 250 groups comprising nearly 9,000 member-firms throughout the country. Experience has shown that growth of membership is due to the effective results obtained through the industrial salvage group meetings, at which both industrial and general salvage matters are discussed and examined from all aspects.

LORD SAMUEL, president of the Parliamentary and Scientific Committee, speaking in London recently, suggested that the Lord President of the Council should exercise the functions of Minister of Science in the Cabinet. He did not advocate the creation of a new Ministry with a new title, but he thought that the President of the Privy Council should have his functions enlarged and his Department expanded, that he should be given an intelligence or information department and be continually watchful of the developments of science here and abroad.

BIRMINGHAM M.P.'s have been taking interest in a proposal by the Board of Trade to transfer to South Wales a contract for aluminium hollow-ware required by the Government. Birmingham, it was declared, has not sufficient labour available to carry out the contract, and it would be necessary to send to South Wales a certain number of skilled men. The Parliamentary Secretary to the Board of Trade agreed to meet a joint deputation of Birmingham M.P.'s and representatives of the Aluminium Hollow-ware Association before transferring the contract.

AMERICAN FOUNDRYMEN'S ASSOCIATION

Mr. Ralph J. Teetor, president of the Cadillac Malleable Iron Company, Cadillac, Mich., has been nominated to succeed Mr. L. C. Wilson, general manager of the Reading Steel Casting Division, American Chain & Cable Company, Reading, Pa., as president of the American Foundrymen's Association. Mr. Fred J. Walls, of the International Nickel Company, Inc., Detroit, has been nominated for the vice-presidency. Both the presidency and the vice-presidency are for one year terms.

The following have been nominated to become directors of the Association for three-year terms:—Mr. Frank J. Dost, Sterling Foundry Company, Wellington, Ohio; Mr. S. D. Russell, Phœnix Iron Works, Oakland, Calif.; Mr. R. T. Rycroft, Jewel Alloy & Malleable Company, Inc., Buffalo, N.Y.; Mr. Joseph Sully, Sully Brass Foundry, Limited, Toronto, Ont., Canada; and Mr. L. C. Wilson.

The annual election of officers and directors will be held at the annual business meeting of the Association, which will take place during the Third War Production Congress, Buffalo, N.Y., from April 25 to 28, inclusive.

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PERSONAL

DR. HARRY R. RICARDO, F.R.S., has been elected president of the Institution of Mechanical Engineers for the year 1944-45.

MR. CHARLES DUNBAR, a managing director of the British Oxygen Company, Limited, has completed 50 years in the industry.

MR. JOSEPH WALTON, assistant managing director of Thos. W. Ward, Limited, Sheffield, has been elected to the board of Marshall, Sons & Company, Limited, Gainsborough.

MR. WILLIAM A. HARRIMAN, works manager of A. Reyrolle & Company, Limited, Hebburn-on-Tyne, has resigned, but his services will still be available in a consultative capacity. Mr. Harriman has been succeeded by Mr. C. Stephens.

LT.-COMMANDER J. F. DIBBEN has been appointed joint managing director of William Dibben & Sons, Limited, iron and steel stockholders, etc., of Southampton. Lt.-Commander G. T. Blake and Mr. D. C. Cameron have been appointed directors of the company.

MR. DONALD J. REESE, chief of the Iron and Steel Manufacture Section, Metallurgical and Conservation Branch, Steel Division, U.S. War Production Board, who is under loan from the International Nickel Company, Inc., New York, has been appointed to the technical committee of the Gray Iron Founders' Society, Cleveland, U.S.A.

MR. ROBERT STUBBS, who has been general manager and secretary of Lowmoor Best Yorkshire Iron, Limited, for the last 14 years, has been appointed a director of the company. The Lowmoor Ironworks are under the control of Thos. W. Ward, Limited, and are among the oldest wrought-iron works in the country, dating back to 1791.

MAJOR ERNEST O. YATES, managing director of Thomas Smith & Sons, of Saltley, Limited, Saltley, Birmingham, has been re-elected president of the Birmingham, Wolverhampton and Stafford District Engineering and Allied Employers' Association. He is also president and chairman of the Association of Drop Forgers and Stampers.

NEW TRADE MARKS

The following applications to register trade marks appear in the "Trade Marks Journal":—

"POWER IMP" (and device)—Agricultural machinery. STEEL & COMPANY, LIMITED, Crown Works, Sunderland.

"FIRMOID"—Building fittings, tubes and sections, etc., made of common metal. BLUEMEL BROS., LIMITED, Wolston, Coventry.

"MINILIFT"—Lifting and lowering tackle. DIDSBURY ENGINEERING COMPANY, LIMITED, 289A, Wilmslow Road, Fallowfield, Manchester, 14.

"MAXIUM"—Cutting compounds for metals. EDWIN TAYLOR (CHEMICALS), LIMITED, 82, Boardman Street, London Road, Manchester, 1.

COMPANY RESULTS

(Figures for previous year in brackets)

United Steel Companies—Interim dividend of 2½% (same).

Clarke, Chapman & Company—Dividend of 12½% (same).

Qualcast—Interim dividend of 10% on the ordinary shares (same).

Braithwaite & Company, Engineers—Interim dividend of 3% (2½%).

Peter Brotherhood—Interim dividend of 8% on the ordinary shares (same).

M. Mole & Sons—Dividend of 10% and a cash bonus of 2½% out of profits for 1943.

Beans Industries—Final dividend of 27½% on the ordinary shares, making 37½% (same).

Evered & Company—Net profit for 1943, £23,673 (£22,098); ordinary dividend of 10% (same).

Darlington Railway Plant & Foundry Company—Interim dividend of 5% on the ordinary shares.

Mather & Platt—Final dividend on the ordinary stock of 6%, making 10% (10% plus 1% from special reserve).

Hammond Lane Foundry—Final dividend of 7% and a bonus of 2½% on the ordinary shares, making 12½% (same); to reserve, £4,000; forward, £4,015.

Henry Meadows—Net profit to August 31 last, £26,492 (£29,363); war damage contribution, £3,138 (£4,000); dividend of 25% (same); forward, £12,325 (£13,971).

Delta Metal Company—Net profit of £74,227 (£82,821); dividend on the ordinary shares of 12½% net and a bonus of 1s. 6d. per share, making 20% tax free (same).

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

J.H.M. Components, 24, Matilda Street, London, N.1—Metal workers, engineers, etc. £1,000. J. H. and D. May.

Kerswell (Metals), Pembroke Buildings, Swansea—Metal and alloy makers, refiners and workers, etc. £2,000. C. G. Kerswell, H. W. Vaughan, and A. R. Williams.

Powdered Metal Products, 13, St. George Street, Hanover Square, London, W.1—£10,000. C. G. Wade, E. G. Walford, R. Hunter, J. R. Rotheroe, H. A. L. Richardson, and R. H. Spiers.

Campbell Metallurgical Development Company, 13, St. George Street, Hanover Square, London, W.1—£5,000. C. G. Wade, J. G. Campbell, R. Hunter, J. R. Rotheroe, H. A. L. Richardson, and R. H. Spiers.

Powdered Metals Development (Holdings), 13, St. George Street, Hanover Square, London, W.1—To acquire the issued shares of Powdered Metal Products, Limited. £1,000. C. G. Wade, J. G. Campbell, R. Hunter, J. R. Rotheroe, H. A. L. Richardson, and R. H. Spiers.

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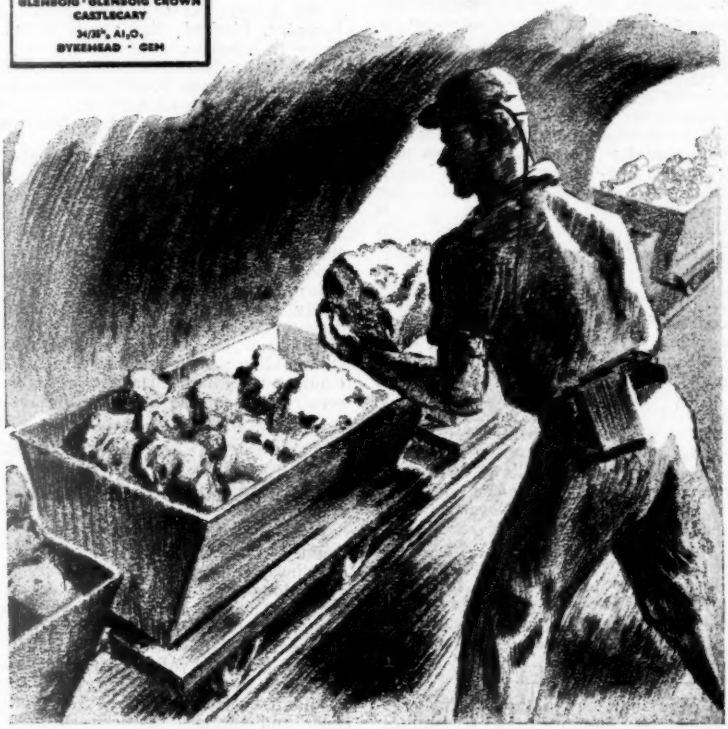

GLENBOIG

Raw Material Markets

IRON AND STEEL

The continued unrest in the coalfields is a source of anxiety in the iron and steel industry, which has been operating on restricted supplies of fuel for a couple of months past. By drawing upon their stocks steelmakers have been able to maintain production, but they cannot continue to do so indefinitely. Fortunately, the demand for most steel products is less urgent, and arrears in deliveries have of late been reduced.

Blast-furnacemen are still relying chiefly on supplies of native ironstone. It would appear that the working of the North African mines is not yet back to normal, and the demands on shipping facilities also restrict the quantity of foreign ores which can be brought into United Kingdom ports. Nevertheless, the supply of practically all grades of pig-iron is keeping well abreast of the demand, and if there be any temporary interruption of deliveries, it is usually due to the wagon shortage rather than the lack of sufficient iron. More low- and medium-phosphorus iron is now available and these grades attract greater interest than common foundry and forge grades. Refined iron is also fairly plentiful, but there has been no relaxation of the restrictions on the use of hematite, which is only released for specific purposes. Work at many of the foundries is held up owing to inadequate deliveries of foundry coke, but blast-furnace coke is accorded special priority and full supplies are coming through.

There has been a slight lull in the flow of new business for re-rolled products, but most of these establishments have an abundance of work in hand, and with an eye to future contingencies are conserving their stocks of semis. Hence the demand for billets, blooms, slabs and sheet bars is undiminished, and good quantities of defective material are being absorbed as they come on to the market.

Activity at the plate and section mills is well maintained. Big tonnages have yet to be delivered before the expiry of the first period. Nevertheless, it would appear that a better balance between supply and demand has been achieved and delivery dates for new orders are not quite so remote. A notable feature of the steel trade is the volume of orders for black sheets. Big tonnages have been booked, and further substantial orders are awaiting acceptance.

NON-FERROUS METALS

The production of magnesium is the subject of a report from the House of Commons Select Committee on National Expenditure. The report comments on the wide variation in the costs of production at the four producing works in this country, and is critical of the action of the Government departments concerned in sanctioning expenditure on certain plant. The total capacity of Britain and the United States for the production of magnesium is now greater than the aggregate demands and, as already reported, it has been decided to close some of the plant in this country. The same position obtains in regard to aluminium—a striking contrast with the situation at the beginning of the war. The steps taken to expand the output of other metals of which Britain was in need for war purposes have been equally fruitful. Copper is now in good supply and production is being reduced. Lead and zinc also are readily forthcoming for essential purposes. Tin is relatively scarce, but with the use of substitutes and economy measures in every direction, the needs of the war factories are being supplied.

OBITUARY

MR. LIONEL ARTHUR JOHN SMITH, of the Heywood Foundry, Limited, died at Heywood, Lancs, on February 14, aged 61.

MR. JOHN CROFT, director of J. & D. Croft & Sons, Limited, galvanisers and hollow-ware manufacturers, died on February 13, aged 88.

MR. ARTHUR HERBERT EDMESTON, a former director of Archibald Edmeston & Sons, Limited, engineers, Patricroft, died on February 6, in his 79th year.

MR. ROBERT ARMITAGE, chairman of Brown Bayley's Steel Works, Limited, Sheffield, and of the Farnley Iron Company, Limited, Leeds, died recently, aged 78.

MR. SINCLAIR COUPER, J.P., formerly of Lindsay Burnet & Company, engineers and boilermakers, Moore Park Works, Govan, died in Glasgow on February 12, in his 88th year.

MR. JOHN M. GILCHRIST died recently at his home at Newton Mearns, near Glasgow. He was a member of a family which has had a long association with the shipbuilding and engineering firm of Barclay, Curle & Company, Limited. He was manager of the Clydeside repair works of the firm, retiring about ten years ago.

CONTRACTS OPEN

A n date given is the latest on which tenders will be accepted. The address is that from which tender forms may be obtained.

Dewsbury, March 6—Iron castings, for the Town Council. Mr. E. Shaw, borough engineer, Municipal Buildings, Halifax Road, Dewsbury.

Londonderry, March 7—Cast and wrought ironwork, for the Town Council. City Surveyor's Department, Guildhall Street, Londonderry.

Maesteg, March 11—Iron castings, for the Urban District Council. Mr. E. Davies, surveyor, Council Offices, Maesteg.

Middlesbrough, February 28—Cast and spun iron pipes and specials, cast-iron surface covers, etc., for the Tees Valley Water Board. Mr. E. A. Morris, clerk, Water Board Offices, Corporation Road, Middlesbrough.

Shrewsbury, March 6—Iron castings for the year ending March 31, 1945. Mr. A. W. Ward, borough engineer.